

REMARKS

This is in response to the Official Action currently outstanding with regard to the above-identified application.

Claims 1-7 were pending at the time of the issuance of the currently outstanding Official Action. The foregoing Amendment amends of Claims 1, 5 and 6.. Claim 7 is cancelled, without prejudice, in view of the incorporation of its subject matter into Claims 5 and 6 respectively. Claim 8 is added. No Claims are withdrawn. Accordingly, upon the entry to the foregoing Amendment, Claims 1 -6 and 8 as hereinabove amended will constitute the claims under active consideration in this application.

The claims as they will stand upon the entry to the foregoing Amendment are reproduced above showing the changes made and with appropriate status identifiers as required by the Rules.

Specifically, in the currently outstanding non-final Official Action, the Examiner has:

1. Acknowledged Applicants' claim for foreign priority under 35 USC 119 (a)-(d) and (f), and confirmed the receipt of the required copies of the priority documents by the United States Patent and Trademark Office.
2. Confirmed his acceptance of the drawings as filed in this application on 8 February 2006.
3. Provided Applicants with a Notice of References Cited (Form PTO-892)

4. Provided Applicants with copies of the Forms PTO/SB/08a/b that accompanied their Information Disclosure Statements of 8 February 2006 and 27 June 2006 respectively duly signed, dated and initialled by the Examiner in confirmation of his consideration of the art listed therein – **Applicants respectfully request similar consideration and confirmation of their Information Disclose Statement filed in this application on 19 May 2008,**
5. Rejected claims 1-4 under 35 USC §102(b) as being anticipated by Kelly (US Patent No. 6,474,573);
6. Rejected claim 5 and 6 under 35 USC §103(a) as being unpatentable over Kelly in view of Schantz et al (US Patent No. 5,442,384). et al.
7. Objected to Claim 7 as being dependent upon rejected base claims, but also indicated that Claim 7 would be allowable if rewritten in independent form including all of the limitations of its base claim and any intervening claims. – **By the foregoing Amendment, Applicants have cancelled Claim 7, without prejudice, and incorporated the subject matter thereof into both Claims 5 and 6. Applicants respectfully submit that this amendment is the equivalent of rewriting Claim 7 in independent form including all of the limitations of its base claim and any intervening claims and that therefore Claims 5 and 6 as amended hereinabove now are in condition for allowance. A decision so holding in response to this submission is respectfully requested.**

No further comment regarding items 1-4 and 6-7 above is deemed to be required in these Remarks.

With respect to item 5 above, Applicants by the foregoing Amendment have amended Claim 1 so as to more clearly indicate that it is **a driving electrode contacting the discharge fluid**, not a counter electrode as is disclosed in the Kelly reference relied upon by the Examiner, that causes an electric charge to be supplied to the discharge fluid.

It is to be noted in this regard that in the atomizer of the Kelly reference (US Patent No. 6,474,573), the counter electrode 50 that applies an electric field for atomizing fluid is formed as a coating on wall 24 (the external wall of the nozzle) and is disposed in the vicinity of the orifice 26 so that the counter electrode 50 and the orifice 26 are almost in contacting relationship with one another. This structure is possible in the Kelly reference only because the atomizer does not require a position controller for the fluid to be atomized from the orifice.

On the other hand, in the image forming apparatus of the present invention, fluid (i.e., ink) to be discharged through the fluid discharge hole of a nozzle is required to control its hit position accurately such that the desired drawing pattern is formed thereby. Also, in the present invention, the fluid is discharged not in the form of a mist as from an atomizer, but rather in a form akin to a string. Accordingly, it will be understood that the counter electrode (if it were to be present at all in the present invention) should be provided at the back of the substrate on which the drawing pattern is to be formed. However, it also will be understood that if the latter alternative were to be adopted, it would make it impossible to arrange the counter electrode and the fluid discharge hole of the nozzle such that they substantially contact one another as disclosed in the Kelly reference relied upon by the Examiner.

In view of the foregoing discussion, therefore, Applicants respectfully submit that the electrode formed as a coating on the external wall of the nozzle of the present invention is correctly classified as a “driving electrode”, rather than a “counter electrode”.

In addition, the Examiner's attention is respectfully directed to the fact that it is described in the present specification that the "counter electrode" (opposing electrode) may be omitted (see present specification, Page 8, line 13 to Page 10, line 2, where it is stated that:

According to the above arrangement, with the nozzle having the fluid discharge hole with a micro diameter (nozzle diameter) ranging from 0.01 μm to 25 μm , a local electric field occurs. This allows reduction in the drive voltage during discharging operation. The reduction in the drive voltage will be a great advantage for realizing downsizing of the device and for high density configuration of the nozzles. Further, the reduction in the drive voltage allows use of a low-voltage driven driver with merit in view of cost.

Further, the above discharge model does not require an opposing electrode because an electric field intensity necessary for discharging varies depending on the local converged electric field intensity. That is, the above discharge model enables printing to an insulating substrate or the like without employing an opposing electrode, thereby allowing for more flexibility in the configuration of the device. Further, printing to a thick insulator becomes also possible.

In a structure in which a drive electrode is provided inside a fluid flow path in the micro nozzle, it is difficult to bring the drive electrode closer to the nozzle hole. In this case, an electrical resistance between the drive electrode and the tip of the nozzle inside the fluid discharge head increases. As a result, a discharge response is degraded.

On the contrary, in the electrostatic suction type fluid discharge device, the electrode section, which applies the drive voltage to charge the discharge fluid, is provided by coating the external wall of the nozzle with conductive material. This facilitates construction of the head in which a distance between the electrode section and the nozzle hole is minimally shortened. That is, by bringing the electrode section closer to the nozzle hole, a drive frequency for causing discharge increases. Further, it allows use of materials with higher resistance for the fluid to be discharged. Further, in the electrostatic suction type fluid discharge device, it is preferable the electrode section constitute at least a part of inner wall of the nozzle.)

Page 23, line 8 through page 24, line 14 of the present specification also is instructive on this point as follows:

Further, the above discharge model does not require an opposing electrode because the electric field intensity necessary for discharging varies depending on the local converged electric field intensity. That is, as to an insulating substrate, the conventional discharge model has required an opposing electrode to be disposed on the opposite side of the nozzle relative to the nozzle, in order to apply an electric field between the nozzle and the substrate. Alternatively, the conventional discharge model has required a substrate to be conductive. When the opposing electrode is disposed (i.e., when the substrate is an insulator), there has been a limitation to the thickness of the applicable substrate.

On the other hand, the discharge model of the present invention enables printing to an insulating substrate or the like without employing an opposing electrode, thereby allowing for more flexibility in the configuration of the device. Further, printing to a thick insulator becomes also possible.

As described above, the electrostatic suction type fluid discharge device of the present embodiment employs the newly proposed discharge model, which takes account of the local electric field intensity. This allows the nozzle to be micro size of 0.01 μm to 25 μm , and also allows a drive voltage of 1000V or lower to carry out a discharge control of the fluid. As a result of considerations using the above model, it is found that a drive voltage of 700V or lower can carry out the discharge control for a nozzle having a diameter of 25 μm or smaller, a drive voltage of 500V or lower for a nozzle having a diameter of 10 μm or smaller, and a drive voltage of 300V or lower for a nozzle having a diameter of 1 μm or smaller.

In this case, a mirror image charge is generated in the substrate and the substrate itself functions as a counter electrode (see present specification at page 18, line 20 to page 19, line 5, whereat it is stated that:

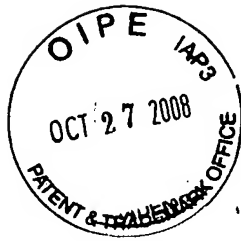
Further, when a conducting substrate is used as the substrate, it would appear that a mirror image charge Q' is induced at a position symmetrical and opposed to the nozzle in the substrate. The mirror image charge Q' has an opposite polarity to that of the charge Q . Similarly, when the substrate is an insulator, an image charge Q' having an opposite polarity to that of the charge Q is induced at a position which is determined according to the dielectric constant of the substrate.

Also, in this case, the substrate functioning as a counter electrode is not arranged in contact (or substantial contact) with the nozzle as disclosed by Kelly.

Accordingly, Applicants respectfully submit that it is clear that the atomizer of the Kelly reference and the image forming apparatus of the present invention are differentiated not only with respect to the field in which each is respectively applicable, but also in their fundamental concepts of operation. As stated previously, the counter electrode 50 of Kelly is disposed closely in the vicinity of the orifice 26, but it does not contact the fluid to be atomized. Accordingly, Applicants respectfully submit that the counter electrode of Kelly cannot be equated to the “driving electrode of the present invention that applies an electric field and directly charges the fluid to be discharged.

A brief comment concerning newly added Claim 8 also appears to be appropriate at this stage of these proceedings. In a case wherein a nozzle is an ultrafine nozzle, in particular one that has a fluid discharge hole with a diameter in a range of 0.01 μm through 25 μm as in the present invention it is technically very difficult to form the ultrafine nozzle. The present invention according to claim 1 is applicable to a method for forming such an ultrafine nozzle having a fluid discharge hole with a diameter in the range of 0.01 μm through 25 μm . In order to make this ultrafine nozzle, a glass tube with high formability is deformed by the addition of heat and stretching force (see present specification at page 27, lines 6-10). In this method, a nozzle to be obtained must have a tapered section, a fact that causes an obvious structural difficulty with respect to the insertion of an electrode wire inside the nozzle. New Claim 8 addresses this problem according to the premise discussed above and in the present specification that the nozzle is a glass tube that allows a fluid discharge hole with a diameter in a range of 0.01 μm through 25 μm to be formed.

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Therefore, it is believed that the claims of this application as they will stand upon the entry of the foregoing Amendment are patentable, and Applicants consequently respectfully request the entry of the foregoing Amendment, reconsideration and allowance of this application in response to this submission.

Applicant believes that additional fees beyond those submitted herewith are not required in connection with the consideration of this response to the currently outstanding Official Action. However, if for any reason a fee is required, a fee paid is inadequate or credit is owed for any excess fee paid, you are hereby authorized and requested to charge and/or credit Deposit Account No. **04-1105**, as necessary, for the correct payment of all fees which may be due in connection with the filing and consideration of this communication.

Respectfully submitted,

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SIGNATURE OF PRACTITIONER

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